# Testing of a Loop Heat Pipe with Two Evaporators and Two Condensers

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## Abstract

Loop heat pipes (LHPs) are versatile heat transfer devices which have gained increasing acceptance for spacecraft thermal control. Most existing LHPs consist of one single evaporator and one single condenser. The operating temperature of the LHP is controlled by the saturation temperature of its compensation chamber. Because the compensation chamber forms an integral part of the evaporator and is located in the path of the fluid circulation, its saturation temperature is a function of the evaporator heat load, the condenser sink temperature and the ambient temperature.

Extending the LHP technology to include multiple evaporators and multiple condensers faces some challenges. For example, there may be sizing limitations with regard to the number of evaporators that can be integrated into a single loop. There are also operating issues that require further investigation, including interactions between individual compensation chambers, operating temperature stability, and loop's adaptability to rapid power and/or sink temperature transients. To help gain a better understanding of these challenges, an extensive test program has been conducted on an LHP with two evaporators and two condensers.

The test loop is schematically shown in Figure 1. The two evaporators are made of stainless steel tubing with 12.7 mm (0.5 inch) O.D. by 76.2 mm (3 inches) length. One evaporator has a titanium wick with pore sizes of about 3 microns, while the other has a nickel wick with pore sizes around 1 micron. The vapor line, liquid line, and the two condensers are all made of 1.59 mm (1/16 inch) O D stainless steel tubing, and have lengths of 1.17 m, 1.17m, 0.51m and 0.51m (46 inches, 46 inches, 20 inches, and 20 inches), respectively. Electrical heaters are attached to each evaporator and compensation chamber, and are separately controlled. The two condensers are attached to two cold plates; each cooled by a refrigerator. Sixty thermocouples are used to monitor the loop temperatures.

Tests conducted include start-up and power cycle with various combinations of heat loads to the evaporators and various condenser sink temperatures, high power, low power, heat transport limits, sink temperature cycle, and active control of the compensation chamber temperatures. Lengthy steps and procedures were taken in order to gain insights on the physical processes involved in the loop operation when it is subjected to various conditions. The test program lasted for more than forty days, collecting over 500 hours of test data. Test results show that an LHP with two evaporators and two condensers can work properly even when subjected to fast transients. However, the loop operating temperatures show many hystereses, more than what have been encountered in an LHP with a single evaporator and a single condenser. Because of the vast amount of information and test data, this paper will only present a summary of the test results. Details of specific subjects of the loop operation will be given in separate papers.

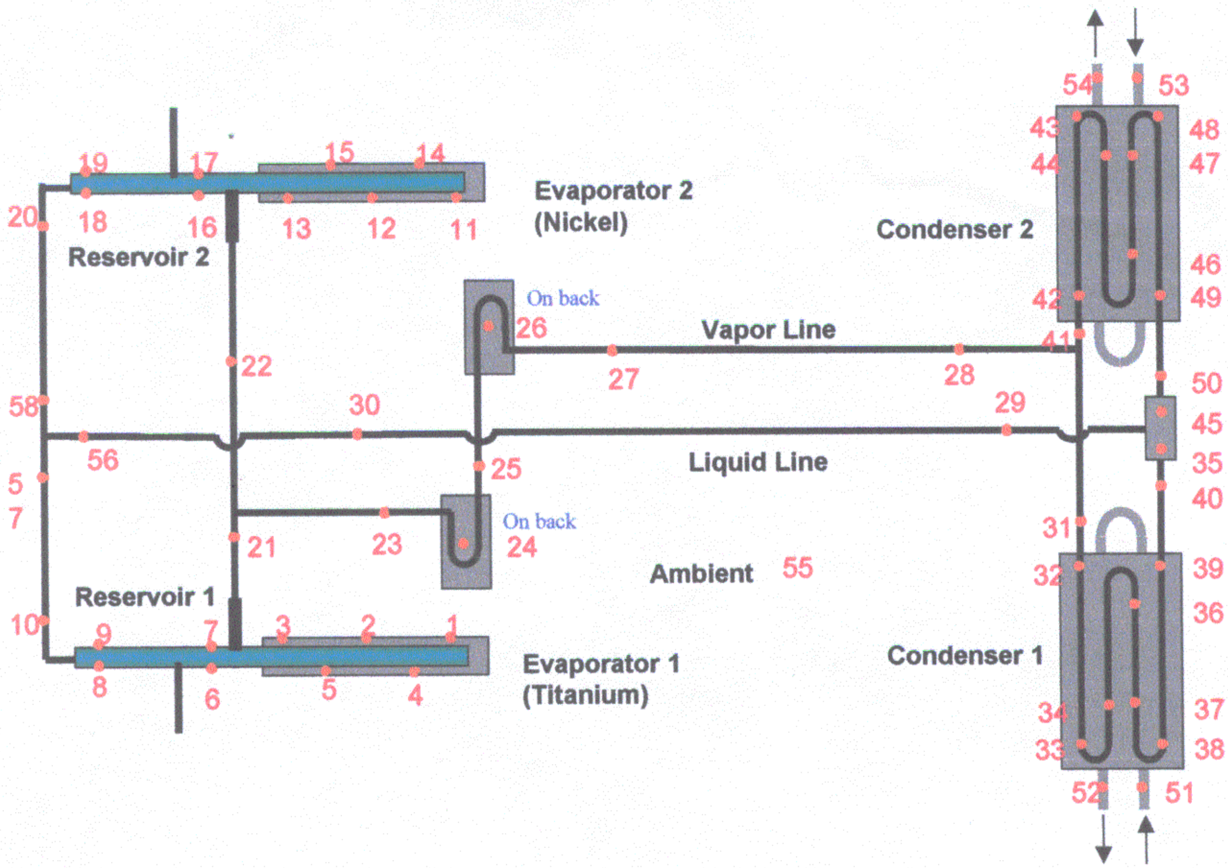


Figure 1 Schematic of an LHP with Two Evaporators and Two Condensers